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**PRELIMINARY EVALUATION OF THE  
OCTOBER 15, 1972 ERTS-1 IMAGERY OF  
EAST-CENTRAL OHIO (SCENE 1034-15415)**

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16. Abstract  This special report presents a general, physical interpretation of ERTS-1 imagery of East-Central Ohio. Special emphasis is placed upon geologic features, such as linear features and hydrologic features. Man-made features are included as a matter of interest and image location. The interpretation is compared to available maps of the area and from this an assessment that ERTS-1 is potentially useful for updating and producing geological maps.			
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(SCENE 1084-15415)

INTRODUCTION

The successful launch of the first Earth Resources Technology Satellite and subsequent receipt of multispectral scanner data provided investigators with an exceedingly large quantity of high resolution information that far surpassed pre-launch expectations. The ERTS imagery provides a synoptic view of a large area that, with continuous reception, will provide data on a wide range of physical, chemical, and biological conditions. Interpretation of this imagery will allow more thorough understanding and better management of our environment.

Geologic and hydrologic information obtained from a study of a single set of ERTS multispectral data (bands 4, 5, 6, and 7) allows a more realistic approach to the evaluation of and potential solutions to existing problems, such as the monitoring of strip mining. These data also permit one to examine lateral changes that occur in geologic units throughout wide areas, which might lead to the discovery of additional mineral resources, a better understanding of geologic processes, or provide clues that in selecting future highway rights-of-way will minimize slumping and maintenance costs. Data on erosion, deposition and pollution loading in streams and reservoirs are also provided. Various linear features may indicate the pattern of fractures in rocks that control the subsurface movement of fluids such as oils or water. Many other bits of information can be gleaned from a direct examination of ERTS imagery, particularly seasonal data, but sophisticated analyses of computer compatible tapes will swing wide the door to an abundance of other possibilities that will permit us to more readily understand, monitor and regulate our environment.

PURPOSE AND SCOPE OF THE INVESTIGATION

The purpose of this report is to describe several man-made, geologic, and hydrologic features revealed on the October 15, 1972, ERTS-1 imagery (Scene 1084-15415) which covers much of east-central Ohio. The 70-millimeter negatives, representing bands 4, 5, 6, and 7, were enlarged so that each of the final prints was about 15 inches square, representing a scale of approximately 1:500,000. For inclusion into this report, all interpreted information was transferred to Bands 5 and 7 and reduced. (Figures 1 and 2). The enlargements were made by standard photographic techniques with

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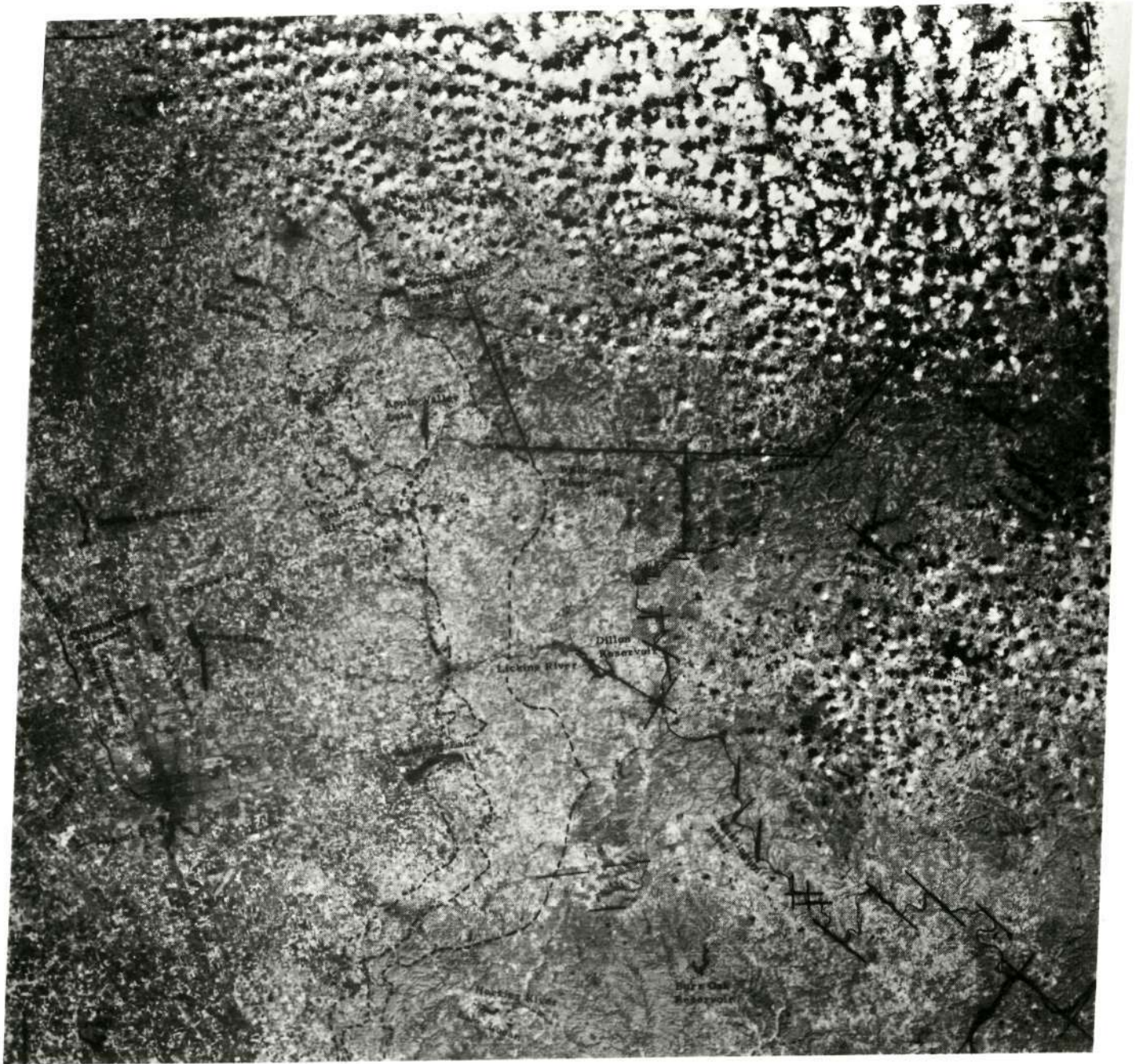


Figure 1 ERTS -1 Band 7  
Scene 1084-15415



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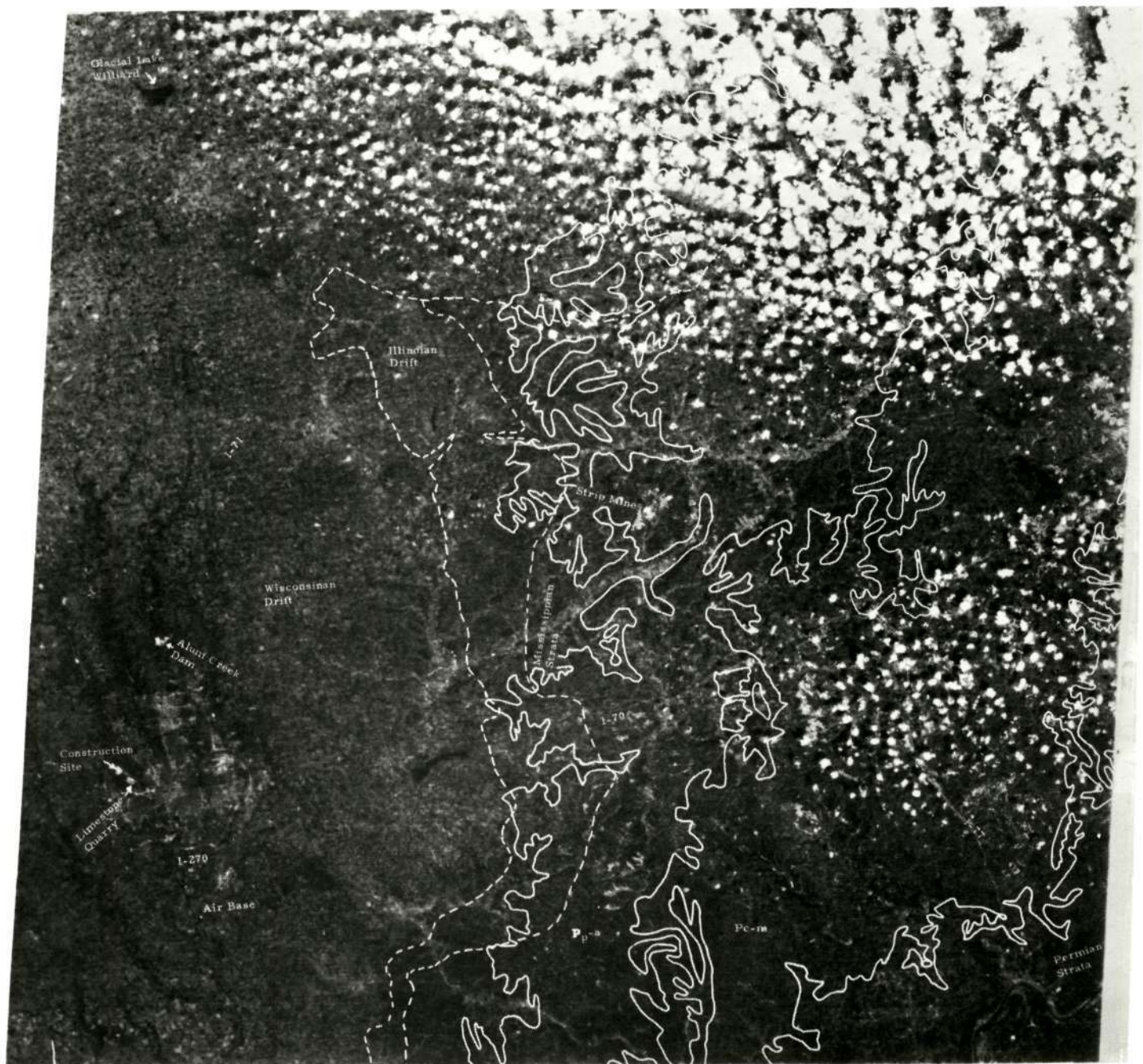


Figure 2 ERTS-1 Band 5  
Scene 1084-15415

minimal quality control. Nonetheless, the final product permitted a recognition of a wide variety of features.

The imagery has about 30 percent cloud cover, much of it in the northern one-third of the area. A few scattered clouds obscure the terrain in the east-central part but elsewhere the sky was largely clear.

## MAN-MADE FEATURES

### Population Centers

An abundance of man-made features are readily visible on all four bands of the imagery (Figures 1 and 2). These include cities and metropolitan areas, roads, dams and reservoirs, airports, excavations, and evidence of farming practices among others. Although several cities, towns, and villages are within the area covered by the imagery, only the City of Columbus is obvious. The greater Columbus area occupies nearly all of Franklin County, which is approximately 25 miles square. The city, many times larger than any other populated area shown on the imagery, is characterized by a distinct spectral response within the area enclosed by I-270 Outerbelt, a four- to eight-lane highway that completely surrounds the city.

Bisecting the city in a generally north-south direction is I-71, while I-70 crosses the southern part in an east-west direction. These major highways consist of concrete and their spectral response contrasts with that of Route 23, (High Street) which parallels I-71. Much of Route 23 has been covered with asphalt, which very likely is the major cause of the contrast between it and most of the other streets and roads in the Columbus area.

Several obvious features enclosed by I-270 include developed and undeveloped areas, parks, golf courses, quarries, and construction sites, as well as such familiar features as airports, dams and reservoirs. A very large area presently being developed into a huge apartment complex lies in the west-central part of Columbus near I-270. Throughout this area the topsoil has been stripped, much of the underlying glacial till has been removed, and limestone is exposed in the central part of the excavation. The construction area, which appears as a very light spot on bands 4, 5, & 6, contrasts but slightly with a similar region about a mile to the south-east. The second area, which also appears as a light tone, represents a

very large limestone quarry into part of which has been dumped a large quantity of lime sludge from the local water treatment plant for the past several years.

Nearly all patterns relating to land-use in Columbus are best identified by using bands 4 and 5. Bands 6 and 7 provide the greatest amount of information concerning surface water reservoirs and flooded excavations such as limestone quarries, gravel pits, and borrow pits.

### Roads and Highways

Roads and highways are most evident on bands 4 and 5. The most obvious of these include the Interstate highways such as I-270, I-70, I-71, and I-77, although state routes that are at least four lanes wide are also evident. Narrower roads can be seen on the imagery in the more hilly areas in the eastern part where they cut through the unglaciated timber-covered bedrock hills.

### Dam Construction

Dams and reservoirs are, of course, most obvious on the infrared bands (6 and 7) when the impoundment contains water. Location of reservoirs under construction, even though they contain no water, can be determined on the ERTS imagery. Of particular interest is the light-colored rectangular area (bands 4 and 5) located a few miles north of Columbus and just to the west of I-71. This represents the area where the Alum Creek Dam is now being constructed. All of the vegetation and soil have been removed from the site, making it a major source of sediment that washes into Alum Creek. The spillway has not been completed and water will not be impounded for several months, or possibly a few years.

Although the Alum Creek dam site has a distinctive signature due to lack of vegetation, it contrasts significantly with Apple Valley Lake, a few miles east of Mt. Vernon. This lake, which began filling in 1970, does not appear to exhibit any type of scar where the soil and subsoil was removed. Either the excavation site at Apple Valley Lake recovered rapidly or a relatively small area was affected.

## Airports

Airports are most easily delineated on bands 4 and 5. Particularly obvious is Lockbourne Air Force Base south of Columbus, which appears to have three major parallel runways (northeast-southwest) intersected by north-south east-west runways. The Lockbourne area differs considerably in spectral response from either Port Columbus at the east-central edge of Columbus or Don Scott Airport in the northwest corner of the city. The runway at Lockbourne is over 12,000 feet long; at Port Columbus it is 10,700 feet long, and at Don Scott it is 4,400 feet long. Even less evident is the east-west runway south of Delaware (25 miles north of Don Scott field), which is 4,100 feet long.

## Excavations

Several types of excavations can be identified by their shape, size, and location. Small rectangular areas that range from a few hundred feet to about a half mile in length, lie along I-71 north of Columbus. These areas represent flooded borrow pits that were excavated for road fill during highway construction. The fact that they are flooded, as indicated by bands 6 and 7, shows that the water table is near land surface. Other major excavations include sand and gravel pits and limestone quarries, which are especially abundant in the vicinity of Columbus. Huge flooded rectangular to pishaped sand and gravel pits, many of which are more than a mile long, occur at the southern edge of Columbus along the Scioto River. Northward along the river, are abandoned and operating limestone quarries. Abandoned quarries are almost invariably flooded and generally are much smaller than the sand and gravel pits. They occur only where the glacial drift that covers the limestone is thin. Limestone quarries being operated are generally most vivid on bands 4 and 5 because the floors of the pits are either above the water table or are kept dry by pumps that lower the water table below the working surface. These light-colored areas (bands 4 and 5) are more irregular in shape than sand and gravel pits or the coal mines found much further to the east.

Abundant coal strip mines are revealed by the imagery in the eastern half of the area. These mines are characterized by disrupted soil and bedrock and can be accurately delineated on bands 4 and 5. Most stripped areas tend to have a dendritic pattern. Differences in strip mine tones from place to place reveal various reclamation schemes. Generally, the



lightest pattern indicates the most recent stripping. In those areas that have been rather extensively reclaimed, as for example those in the southeastern part of the area, much of the lighter tone and pattern characteristics are missing.

In contrast to other disrupted areas, many of the strip mines can best be studied and delineated on bands 6 and 7. Of these, band 7 is by far the most usable. Not only is it possible to delineate areas that have been stripped, but lakes, which commonly form between the stripped area and the highwall representing unstripped material are also evident. Unquestionably, it will be possible to not only map the areal extent of strip mining, but also to evaluate the effects of reclamation.

## GEOLOGIC FEATURES

Several types of geologic features (Figures 1 and 2) are evident on the imagery and it is strongly suspected that a careful evaluation of the data will provide insight into the geologic history as well as the mineral and water resources of Ohio. The imagery can be used to determine various types of linear features, such as faults and joints, aid in the mapping of various geologic formations and glacial deposits, and relate rock type or form to man's activities.

### Linear Features

Although numerous linear features are evident on the ERTS imagery, their significance is not revealed by existing geologic literature dealing with Ohio. Careful study of the various patterns might lead to additional tectonic studies or a reevaluation of the potential availability of economic mineral deposits including high-yield areas of wellwater supplies.

Basically, there are two major types of linear features evident in the eastern half of the imagery of Ohio. Along a north-south strip beginning at the western edge of the imagery and extending eastward to the east margin of Columbus, are a number of lineations that trend north-south. They are exemplified by the water courses, such as the Olentangy and Scioto Rivers. Reservoirs are also aligned in the same general direction. These lineaments are probably controlled by the strike of the bedrock units. In this region, for example, the bedrock strikes in a more or less north-south direction and dips to the southeast.

In addition to the linear features related to streams flowing along the strike of bedrock deposits, are those characteristic of the unglaciated terrain in the eastern part of the State. They can be mapped by using two different techniques:

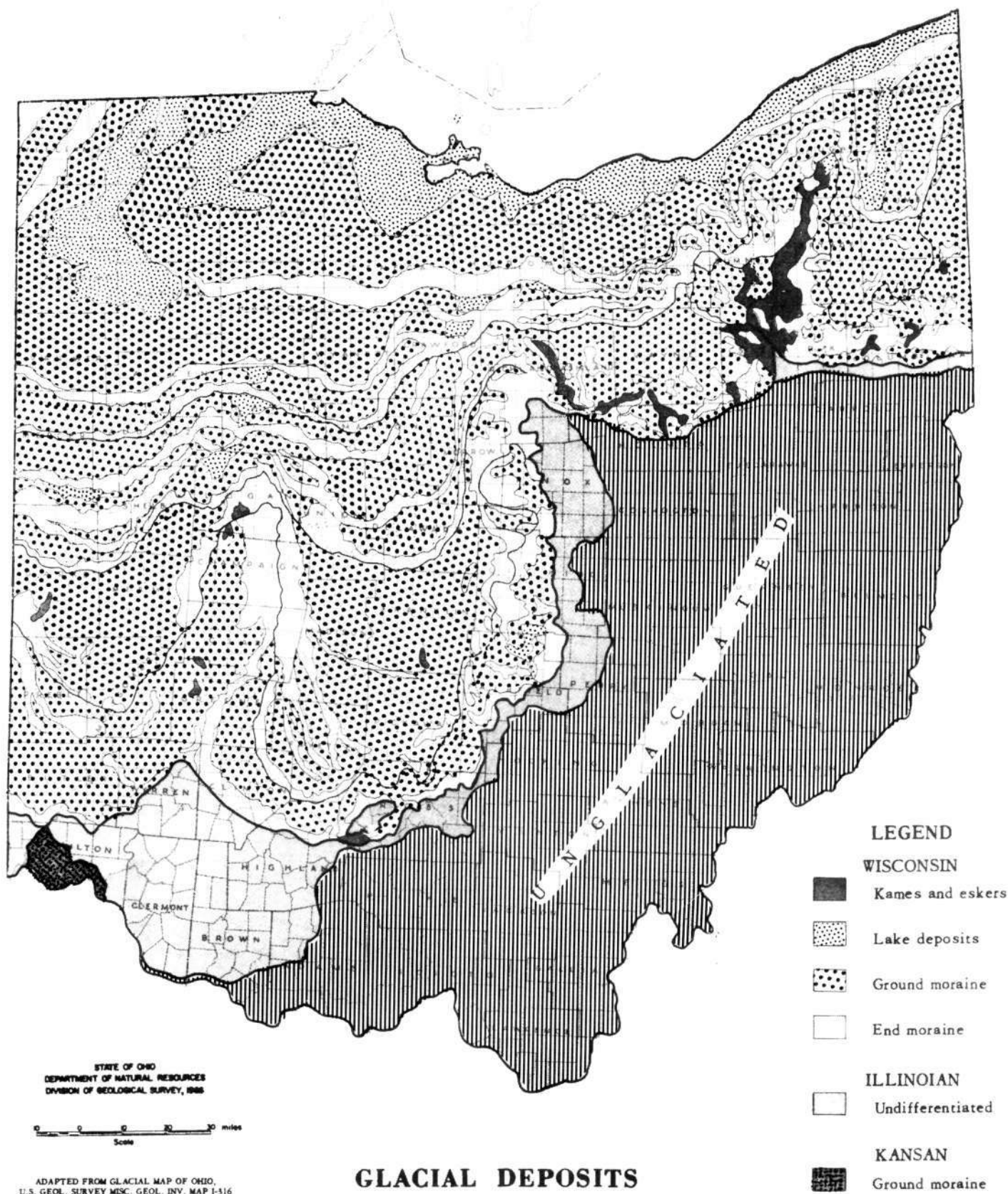
1. Linear features characterized by straight, wide, valleys. These are most readily examined on bands 4 and 5.
2. Straight reaches of streams and rivers in which the channels are wide enough to be delineated on bands 6 and 7.

Perhaps the best example of the first type is found in the central part of the imagery. Starting just east of Apple Valley Lake is the eastward trending valley of the Kokosing River that flows into the Walhonding. The east-west trend continues into the Tuscarawas River Valley and thence turns northeastward. This linear feature, which is nearly 50 miles long, may be structurally controlled. Similar though shorter east-west trends can be seen, among many others, in valleys south of Dillon Reservoir and along the Mohican River where it flows into Pleasant Hill Reservoir.

The second type of lineation is best studied by examining the trend of the Muskingum River. At the confluence of the Walhonding-Tuscarawas-Muskingum Rivers, the major channel extends southward. A similar parallel trend is noticed throughout many relatively short segments of the river all the way to its confluence with the Ohio River. In addition to the north-south trend, a second pattern, exemplified not only by the Muskingum and Ohio Rivers, but also by the trend of reservoirs such as Dillon, Glendening, Piedmont and Salt Fork among others, trends northwest-southeast, a third pattern trends northeast-southwest, while a fourth set extends in a general east-west direction. Interestingly enough, these trends are very similar to the joint patterns that exist, on a much smaller scale, in limestone quarries in the Columbus area.

#### Glaciated Areas

The western half of the area has been glaciated. (Figure 3 and broken lines on Figures 1 and 2). Glacial deposits of Illinoian age extend eastward, beyond the limits of younger deposits, to a north-south trending belt ranging from one mile to about 13 miles wide. To the west and north of this belt Illinoian deposits are covered by Wisconsinian age till and related rock types (Figures 1, 2, and 3).



## GLACIAL DEPOSITS

### OF OHIO

Figure 3

The boundaries separating Illinoian till from bedrock strata and the contact between the Illinoian and Wisconsinian deposits were transposed from the Glacial Map of Ohio (Goldthwait et al, 1964) to the enlarged imagery. In many areas there appears to be good agreement between the mapped contacts and the gross spectral response of the imagery. Elsewhere the boundaries are difficult to locate. The younger drift is characterized by a rectangular or patchwork agricultural pattern showing a considerable range in tone. Although the older drift also reflects farming practices, field size, crop type, and tonal contrast are considerably reduced compared with conditions in younger drift areas.

In most areas that include the drift-bedrock border, changes in relief between the two regions are quite distinct, with bedrock areas showing considerable difference in topography as exemplified by road patterns, stream valleys, and relatively steep slopes. It should be borne in mind, however, that the easternmost part of the Illinoian drift was mapped in the field on the basis of soil characteristics, boulders and thin patchy deposits of till. The boundary is difficult to locate in the field because most of the land forms are more typical of bedrock than of glacial deposits. In view of this problem it is little wonder that it is difficult to accurately locate this particular boundary on the imagery.

Several Wisconsinian end moraines, which arc to the south and west in the western part of the area, can be fairly accurately mapped on ERTS imagery. The moraines generally appear as narrow (1 to 3 miles) bands that are lighter than the surrounding terrain. This is due, in part, to the greater depth to the water table in the topographically higher belts compared with that in the lower-lying ground moraine. Many of the agricultural fields, both on end moraines and ground moraines, are drained by field tile systems.

Glacial lake deposits form generally wet areas that have a high organic content, and appear on the imagery as dark or black areas, especially on bands 5, 6, and 7. By far the most obvious of these deposits on the imagery is glacial Lake Willard (northwest corner), which is bounded by two end moraines. These lake deposits, which consist of a very rich black and wet organic soil, are heavily farmed and are the basis for a major celery growing region. Individual rectangular fields are readily visible on all channels, but particularly on bands 6 and 7.

Partially filling the valleys of parts of the Tuscarawas, Muskingum, and Scioto Rivers, are extensive deposits of outwash. These water-saturated sand and gravel deposits tend to have fairly distinct patterns and tones. The patterns reflect the topographic expression of the deposits while the differing tones seem to indicate changes in both lithology and moisture content. These features are best depicted on bands 5, 6, and 7. Similar signatures typify alluvial deposits along Alum Creek and the Walhonding, Tuscarawas and Muskingum Rivers.

### Unglaciaded Areas

Bedrock formation boundaries were transferred from the Geologic Map of Ohio (Bownocker, 1920) to the imagery. The geologic map is greatly in need of revision and, because of this, many contacts are subject to change. Bedrock deposits east of the Illinoian drift border consist of southeastward dipping Mississippian-age shale, sandstone, and limestone (Figure 4 and broken lines in Figure 2). Further east these strata are covered by the Pottsville and Allegheny Formations of Pennsylvanian age, consisting of coal, sandstone, shale and limestone. The Pottsville and Allegheny Formations, in turn, are concealed still farther to the east by interbedded layers of shale, sandstone, coal, and limestone of the Conemaugh and Monongahela Formations. The youngest bedrock unit is the Dunkard Group of Permian age that consists of shale, sandstone, and coal. Thirty-eight coal seams in the Pennsylvanian and Permian rocks have been named, and there are several other thinner units. Some of these coal beds have been mined since 1804.

The bedrock formations are similar in lithology and it is surprising to find that it is possible to delineate several of these on the ERTS imagery.

Mississippian strata appear to have a subdued relief and may appear darker than adjacent deposits. Pottsville and Allegheny strata contain an abundance of strip mines, are commonly lighter, and show a different relief pattern and tone than either the Mississippian rocks or the Conemaugh and Monongahela formations to the east. The latter two units also support many strip mines but their most distinctive characteristics are their more rugged terrain and herringbone-like pattern along the major drainage ways. Although at first glance, the spectral response of all the formations seems subtle, a careful examination shows the features to be quite distinct. The Dunkard strata, which are exposed along the Ohio River in the southeast part of the area covered by the imagery generally tend not to show abrupt changes in relief and appear flatter with a much lighter tone. On band 5 the tones are lighter than for any other bedrock type.



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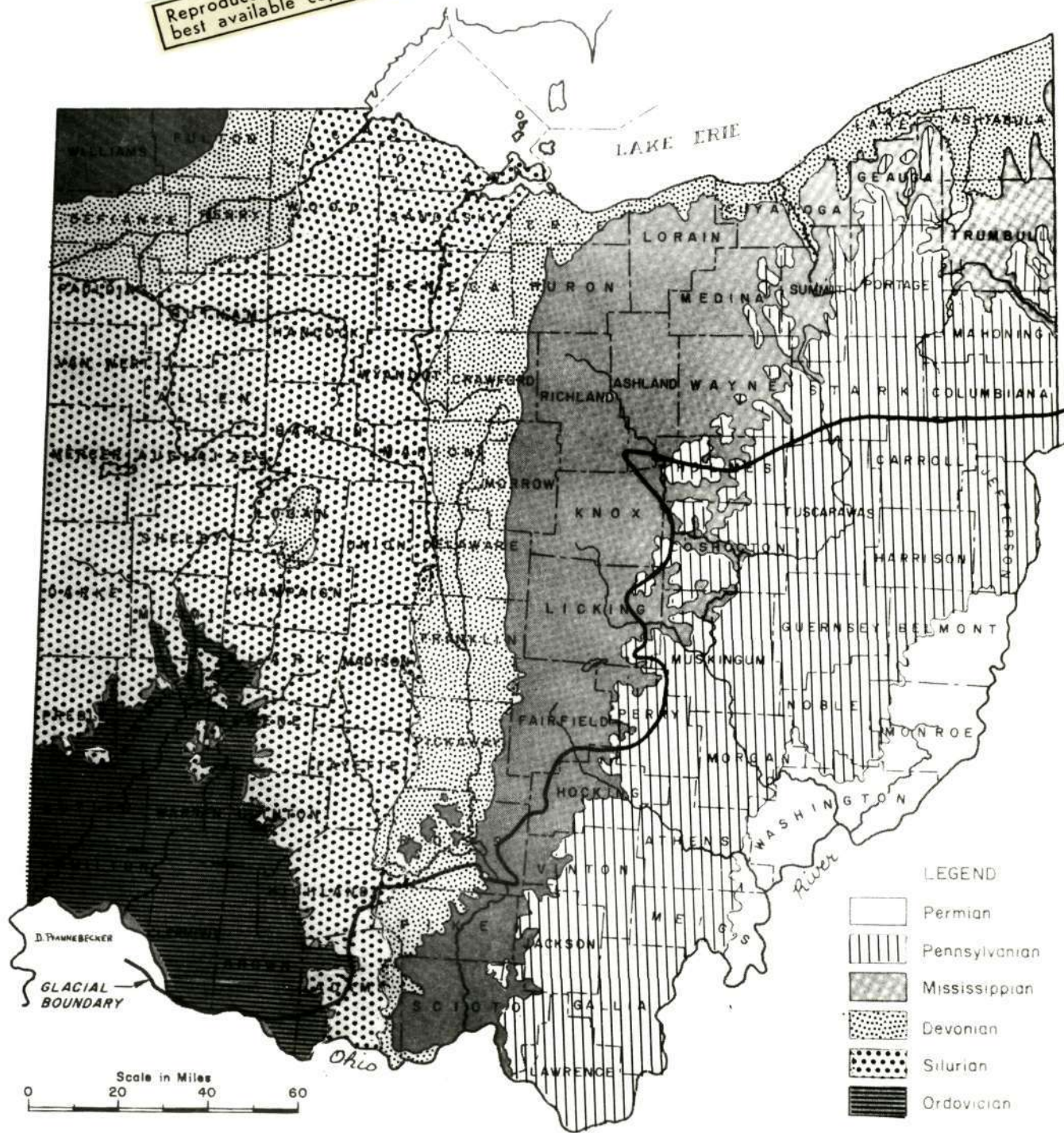


Figure 4 Geological Map of Ohio

The features that help in distinguishing between these major rock units depend in large part on the percentage and thickness of individual layers, which account for changes in relief, moisture content, slope and vegetation.

## HYDROLOGIC FEATURES

### Ancient Drainage Patterns

The major drainage pattern in Ohio was considerably different in past geologic ages than it is at present. Before the Ice Age, major tributaries flowed into the Teays River system of which the master stream flowed northwestward from the vicinity of Portsmouth into Indiana south of Ft. Wayne. Several large streams of this system drained much of what is now east-central Ohio (Figure 5). East of the glacial drift borders, the channels of a few of these rivers are still evident, in the form of wide, flat-bottomed valleys, containing underfit streams. Elsewhere the valleys have been filled with glacial materials and can only be located by test drilling.

Where there is some topographic expression, the ancient valleys can be easily mapped on ERTS imagery. An excellent example is the valley of the former Cambridge River that had its headwaters in Tuscarawas County (Figure 5). The drainage was blocked during the Ice Age and the modern Tuscarawas River flows through much of the ancient channel. The upper part of the Muskingum River also occupies a short reach south of Coshocton. The former river turned southwestward a few miles south of Coshocton and continued to Newark, where it was joined by the ancient Groveport River. From Newark the Cambridge River flowed south toward the west end of what is now Buckeye Lake, but its exact course is hidden by glacial till. The upper reaches of these ancient river systems can easily be delineated on the imagery using, in order of decreasing effectiveness, bands 5, 4, 7, and 6.

Where the valleys have been hidden by an infilling of glacial till, their trend is largely obscured. Some subtle tonal differences on all four bands, however, may be used to locate them. Additional work along these lines is urgently needed as these valleys commonly contain extensive deposits of saturated sand and gravel that offer a large potential for water-supply development. Presently, the search for them is based entirely on test drilling, which is extremely expensive and time-consuming.

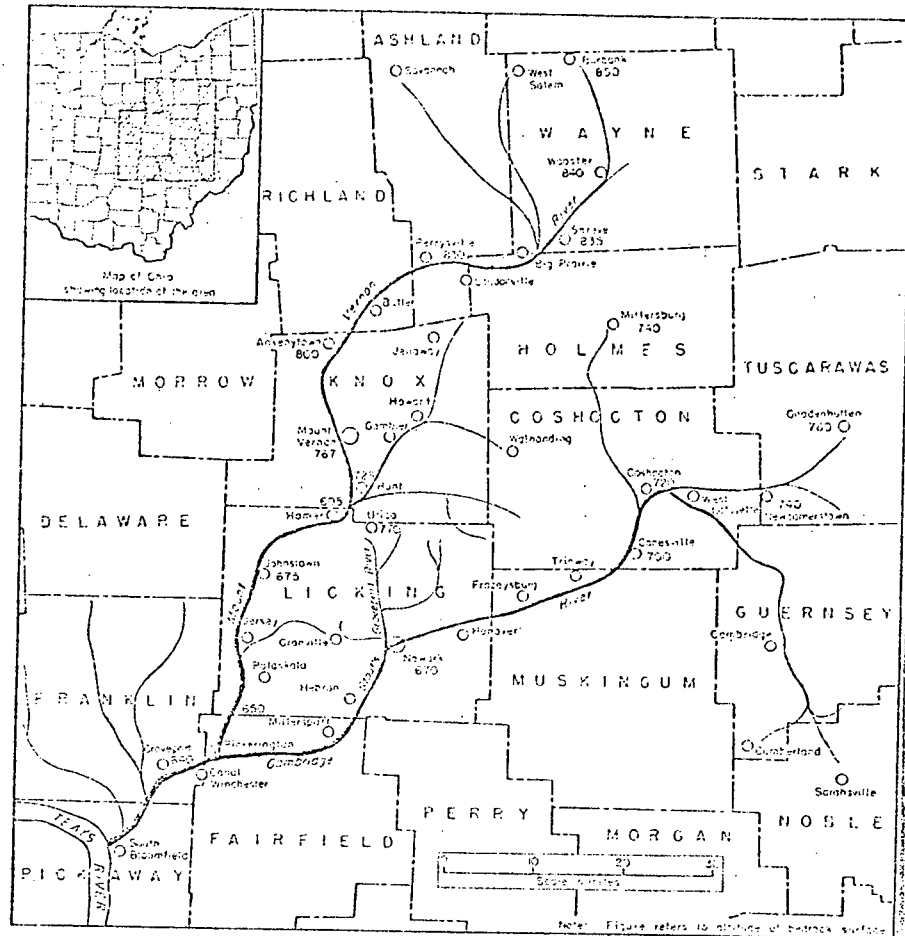


Figure 5 Courses of the Teays-Stage Mt. Vernon and Cambridge Rivers (from Dove, 1960, p. 123)

## Reservoirs

Although reservoirs can be clearly distinguished on bands 6 and 7, there are obvious to subtle differences between them on bands 4 and 5. Data concerning the reservoirs are shown in Table 1.

Perhaps one of the most interesting water bodies is Buckeye Lake, which is clearly discernible on all four bands. Buckeye Lake is very old and represents the remains of an old canal. In fact, a careful examination of band 6 or 7 permits one to trace the former tow path along the canal. Water has been impounded at the site since 1832.

Owing to its age and the abundance of homes along the shore, probably all of which use septic tanks or cesspools that ultimately drain into the lake, Buckeye Lake is characterized by an abundance of algae. Thick deposits of rich organic mud cover much of the bottom. Moreover, peat deposits that underlie the lake, commonly break free and float to the surface during the summer, affording a hazard to boaters and water skiers. Additionally, the water is highly turbid due to the abundance of suspended mud and algae. These conditions account for the unusual signature of Buckeye Lake.

In contrast to Buckeye Lake is the recently developed Apple Valley Lake near Mt. Vernon. This small reservoir shows up on all four bands, although the impoundment is only two years old. Perhaps the signature of Apple Valley reflects an abundance of sediment and organic matter due, not to aging, but to the inwash of material as the surface area of the lake continues to grow.

Reservoirs that lie on agricultural areas of low relief, typical of till plains, are difficult to identify on bands 4 and 5 in contrast to those in hilly eastern regions. Very possibly the tonal differences are related to sediment content and turbidity of the reservoirs and the streams that feed them. The streams in the glaciated areas appear to carry a greater, though finer, sediment load than those in bedrock regions. One would also suspect a greater nutrient concentration due to fertilizers and sewage in the eastern agricultural areas.

Recent convective storms or frontal precipitation may account for some of the differences in reservoir spectral response. For example, Senecaville Reservoir, although clearly discernible on bands 6 and 7, is nearly invisible on band 5. This contrasts with such reservoirs as Salt

Reservoir	Date	Bedrock				Glacial		Evident in Bands			
		Dev.	Miss.	Pp-a	Pc-m	Wisc.	Ill.	4	5	6	7
Apple Valley	1970		X <sup>3</sup>				X		X	X	X
Buckeye <sup>5</sup>	1832		X <sup>3</sup>					X	X	X	X
Burr Oak	1952			X						X	X
Charles Mill	1936		X <sup>3</sup>							X	X
Clear Fork	1953		X <sup>3</sup>							X	X
Clendenen	1937				X				X <sup>1</sup>	X	X
Deer Creek	1968	X <sup>3</sup>				X				X	X
Delaware	1947	X <sup>3</sup>				X				X	X
Dillon	1959			X						X	X
Griggs	1908	X <sup>3</sup>				X			X <sup>2</sup>	X	X
Hoover	1955	X <sup>3</sup>				X		X	X <sup>2</sup>	X	X
Knox <sup>4</sup>	1954		X <sup>3</sup>			X			X	X	X
Lake Logan	1955		X							X	X
O'Shaughnessy	1925	X <sup>3</sup>				X			X <sup>2</sup>	X	X
Piedmont	1937				X			X	X <sup>1</sup>	X	X
Pleasant Hill	1938		X <sup>3</sup>			X			X <sup>2</sup>	X	X
Salt Fork	1967			X					X <sup>1</sup>	X	X
Senecaville	1937				X			X	X <sup>2</sup>	X	X

1. Shallow part of reservoir not evident in this band.
2. Evident but very difficult to delineate on this band.
3. Age of bedrock underlying glacial deposits; may crop out in or along reservoir.
4. Filled in 1949, drained, 1950, refilled, 1954.
5. Former canal.

Dev. - Devonian  
Miss. - Mississippian  
Pp-a - Pennsylvanian; Pottsville, and Allegheny  
Pc-m - Pennsylvanian; Conemaugh, and Monongahela

Table 1. Reservoir Data



Fork, Piedmont and Clendening, which lie a few miles to the north and can be easily delineated on band 5. These four water bodies occur in very similar geologic and topographic terrain. In spite of a few obvious difficulties, a great deal of information concerning reservoirs could be retrieved from further study of ERTS imagery.

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